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Explaining Radical Technology-Based Innovations in Organizations

Uri Gal
Case Western Reserve University

Kalle Lyytinen
Case Western reserve University

Jessica Carlo
Case Western Reserve

Gregory Rose

EXPLAINING RADICAL TECHNOLOGY-BASED INNOVATIONS IN ORGANIZATIONS

Abstract

We propose a causal model to explain radical IS innovation. Based on the presence of a combination of predictors the model explains three types of radical IS innovation: (1) radical base innovations, i.e. breakthroughs in computing architectures; (2) radical process innovation; and (3) radical service innovation. We conduct a cross-sector field study to validate the model and identify which factors predict each of the three types of innovation. We also examine which factors increase the likelihood of a firm becoming a disruptive innovator, which engages simultaneously in all three types of innovation. Consistent with Swanson (1994) and Grover et al (1997) we confirm that each radical IS innovation type is caused by a different combination of factors. Overall, radical IS innovation is determined primarily by an organization's knowledge depth, knowledge diversity, and ability to sense technological changes in its environment. Our findings support the claim that IS innovation research needs to differentiate its explanations by IS innovation type.

Keywords: Internet computing, innovation theory, radical innovation, system development, IS applications.

1. INTRODUCTION

Existing Information System (IS) innovation research primarily seeks to explain the adoption of *singular, incremental* information technologies (IT) by individuals, groups, or organizations (see e.g. Prescott et al. 1995; Swanson 1994). Research about the causes of *multiple, associated radical* IS innovations has been scarce despite the growing number of technological breakthroughs which have fundamentally reshaped the IS practice. In particular, there is a lack of research into the reasons organizations adopt radical computing capabilities and transform them into original IS services and processes.

In this paper we seek to address this gap. We follow Swanson's (1994) suggestion to distinguish among different types of IS innovations and differentiate among three types of radical IS innovations: 1) radical base innovations, defined as breakthroughs in computing architectures; 2) radical innovations in development processes; and 3) radical IS service innovations. We draw upon a radical innovation model (Carlo et al. 2005; Lyytinen et al. 2003a; Lyytinen et al. 2003b) to uncover the factors that affect each of the three types of radical IS innovation and the factors that increase the likelihood of organizations to become *disruptive IS innovators,* which engage simultaneously in all three types of innovations.

The remainder of the paper is organized as follows: after defining the concept of radical IS innovation and the radical IS innovation model, we lay out our hypotheses concerning the factors that affect radical IS innovation. We then describe a cross-sector survey of organizations that have adopted Internet computing technologies to validate the hypotheses. We conclude by outlining the limitations and implications of our findings for IS innovation research and practice.

2. EXPLANATIONS OF RADICAL IS INNOVATIONS

2.1 Radical IS Innovation

Innovation can be described as an idea, product, or technology that is new to the adopting unit (Zaltman et al. 1973). Innovations have been traditionally classified either as radical or incremental depending on the degree of new knowledge that must be identified, garnered and assimilated to appropriate them, and the associated height of learning barriers (Dewar & Dutton 1986, Attewell 1992). Radical innovations (Hage 1980, Zaltman et al. 1973, Dewar & Dutton 1986) have been defined as possessing three characteristics: (1) they significantly depart from existing alternatives and are dissimilar from current structures and processes (Zaltman et al. 1973); (2) their deployment necessitates assimilating new cognitive frames (Bijker 1992); and (3) they influence future innovations and are therefore transformative for surrounding structures or processes (Dahlin & Behrens 2005, Dosi 1982). Radical IS innovations entail new architectural principles and technological components that together or separately significantly drive down costs or fundamentally change services or products (Henderson & Clark 1990), disrupt technological trajectories (Dosi 1982), and imply changes that are risky and costly (Dewar & Dutton 1986). They define new business problems or seize unforeseen opportunities, and thus necessitate explorative adaptations (March 1991), which require organizations to face a considerable burden to acquire substantially different technological and process knowledge (Attewell 1992; Fichman et al. 1997).

2.2 Disruptive IS innovation

To date, only a few scholars have applied the idea of radical innovation to examine IS innovations (Attewell 1992; Carlo et al. 2005; Christensen, 1997; Lyytinen et al. 2003a; Lyytinen et al. 2003b). Early radical innovation studies (e.g. Attewell 1992) treated IS innovations as a black box and focused on changes in the volume of technological and organizational innovations while ignoring the nature of different types of IS innovations. Recently, some scholars have investigated radical process innovations (Fichman et al. 1997; Pries-Heje et al. 2004). Yet, these studies neither explicitly draw on theories of radical innovation nor systematically distinguish among types of IS innovations. In the last few years,

Lyytinen and Rose (2003a), and Carlo et al. (2005) advanced a model of disruptive IS innovation where innovation is modeled as a set of interconnected innovations of different kinds:

1. Radical Base Innovations – transformative changes in computing capabilities and architectures.
2. Radical Process Innovations – original and unique ways to develop and design computing applications.
3. Radical Service Innovations - original services that draw upon unique ways of applying radical base innovations.

According to the model, a firm becomes *a disruptive innovator* if its IS innovations cut across all three sets of radical innovations. Therefore it is important to study each radical innovation type both separately and in combination, and identify the forces that underlie the adoption of each type of innovation, and of all of them combined. This also aligns with claims in IS innovation studies (e.g. Swanson 1994; Grover et al. 1997) that identifying the type of innovation is necessary for understanding an organization's adoption behaviors.

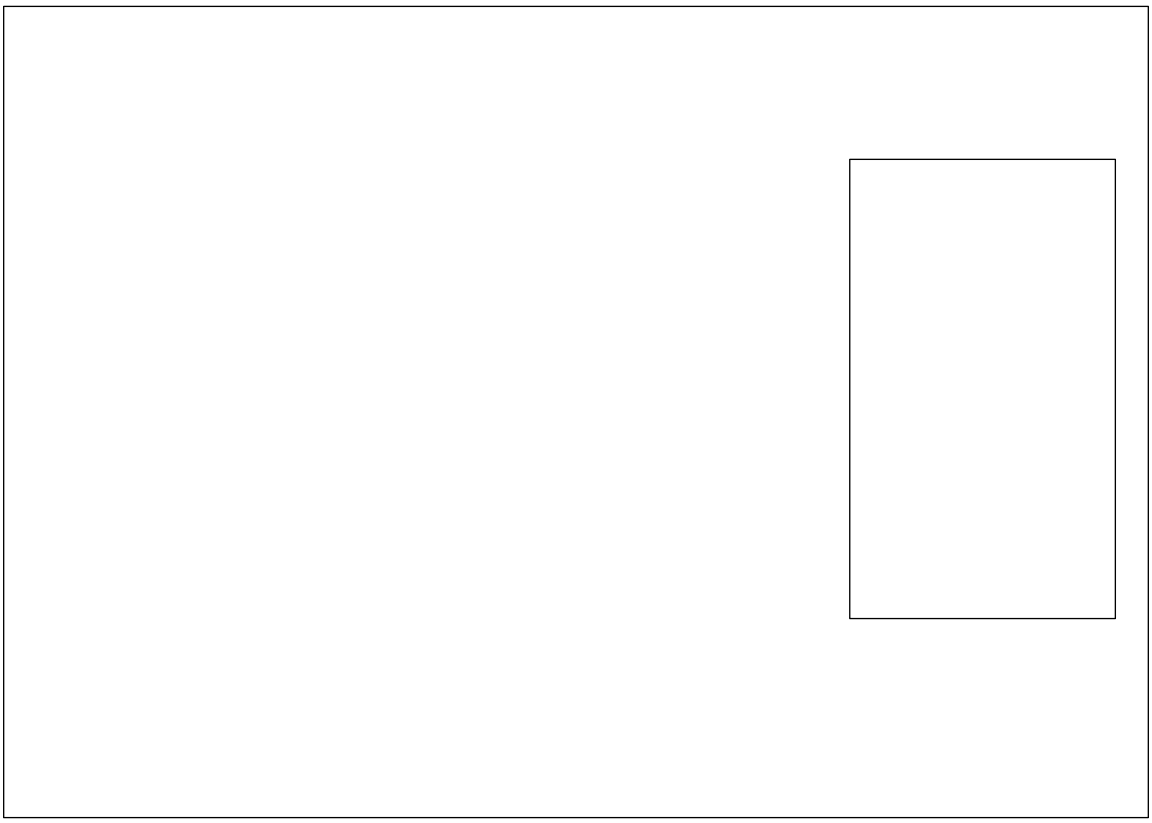
2.3 Radical Innovation Model

Given the characteristics of radical innovations, several scholars (Dewar & Dutton 1986, Hage 1980, Tushman & Anderson 1986) have pointed out that predictors of radical and incremental innovation may differ. Based on this we formulated a model of radical IS innovation (Figure 1) that explains: 1) the amount of radical innovation in each of the three types of IS innovation; and 2) the likelihood of becoming a disruptive innovator. Being innovative is defined by the amount of different types of radical IS innovations adopted after a radical capability becomes available, and by whether an organization adopts all three radical innovation types. Since we assume that antecedents for radical innovation differ significantly from those of incremental innovation, we have integrated into this model only factors that have been previously found to specifically explain radical innovation[1]. Overall, we identified four factors that affect radical IS innovation. We postulate that each factor can affect radical innovation in base technologies, services and processes. The proposed model, however, assumes that antecedents for each type of radical IS innovation will vary due to their different content and the variation in the forms of knowledge they require (Grover et al. 1997; Swanson 1994).

3. RADICAL INNOVATIONS HYPOTHESES

Next we formulate hypotheses that articulate the distinct impact of each factor on each IS innovation type and thereafter its impact on the likelihood of a firm becoming a disruptive innovator:

[1] We did not include the following factors that have been found to promote or inhibit innovation in general (Damanpour 1991): specialization, functional differentiation, professionalism, formalization, centralization, managerial attitude, managerial tenure, technical knowledge resources, administrative intensity, slack, external communication, internal communication, and vertical differentiation. Some factors including specialization, technical knowledge resources, and external communication overlap with included predictors.



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